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ABSTRACT

This module provides instructions for clarifying cooking oil and using it with either wood ash lye or commercial lye to make laundry soap. It also provides (in appendices): a discussion of oils and soaps, including the history of soap; instructions for preparing an 18 percent lye solution; instructions for preparing soap using lye from wood ash; and a discussion of how soap cleans. A glossary and a short list of references are included. (JN)

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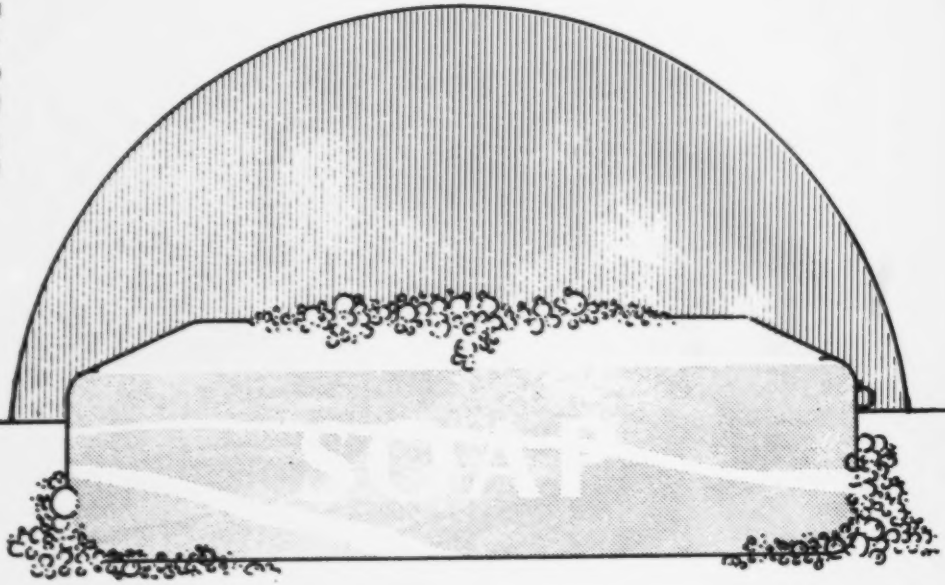

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Science and Technology Education in Philippine Society

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# LAUNDRY SOAP from waste COOKING OIL

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## LAUNDRY SOAP FROM WASTE COOKING OIL

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# Laundry Soap from Waste Cooking Oil

Figure 1

You have probably watched sidewalk vendors frying peanuts, bananas or fish balls. Did you notice that they use the oil over and over again?

Nutrition experts say that oil should not be used when it is already dark in color and gives off an irritating odor.

Biochemists explain that vegetable and animal oils decompose at high temperatures to give substances harmful to health. One of these, acrolein* is suspected to cause cancer.

There is no need, however, to throw away the used oil which could pollute our waterways. It can be clarified and used with wood ash lye[1] or commercial lye to make laundry soap. But before trying to clarify used oil and make soap, you might be interested to know more about oils and soap. See Appendix 1. Try this procedure to make laundry soap from waste cooking oil.

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*For definitions of the words with asterisks in this module see the glossary.

[1] For preparation of wood lye see module "Lye from Wood Ash", SEC Publication, Diliman, Quezon City.

A. Clarification of Waste Cooking Oil

Materials

| | |
|---|---|
| funnel | stirrer |
| cotton cloth | stove |
| used cooking oil | kettle |
| measuring cup | glass bowl or bottle |
| water | |

Procedure

1. Filter the oil through several folds of cotton cloth to remove the coarse solid deposits.

Figure 2

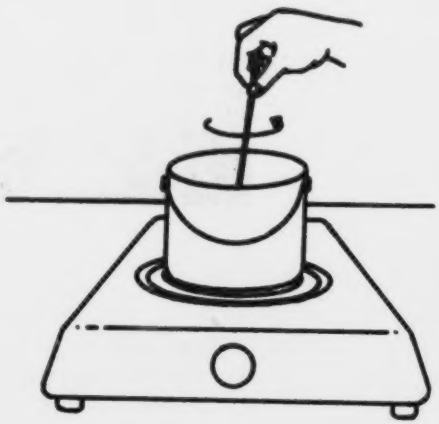

Figure 3

2. Measure the volume of the oil. For every cup of oil add a cup of water, stirring as you do so.
3. Boil the mixture, stirring occasionally.
4. Remove from fire and pour into a bowl. While stirring add 4 more cups of cold water for every cup of oil. Set aside to cool to let the oil and water layers to separate.
5. Remove the oil layer at the top. Repeat steps 2 to 4.
6. Allow the mixture to stand until the oil layer on top is clear.
7. Remove the oil layer and filter once more through cotton cloth.

B. Preparation of Laundry Soap Using Commercial Lye (NaOH)

Materials

measuring cup
enamel, iron or earthenware kettle for warming lye
another kettle for warming oil
2 wooden stirrers
molds such as a square can, small coconut shell halves, small bowls or cardboard boxes
a piece of cotton cloth
clarified oil
18% lye solution (see Appendix 2 for preparation)

Procedure

1. For every cup of oil, use 3/4 cup of 18% lye and put them in separate containers.
2. Warm both the oil and lye until the containers feel uncomfortable to touch (about 45°C).

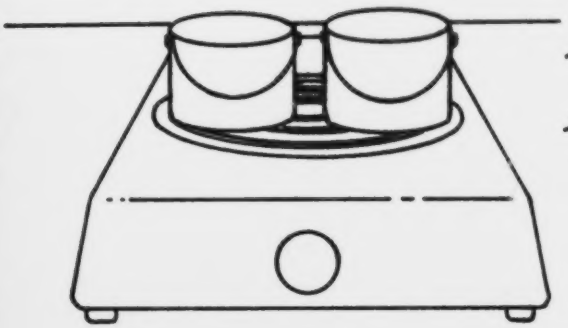

Figure 4

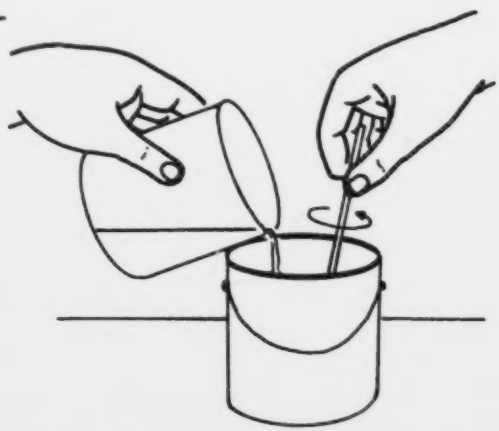

Figure 5

3. Pour the lye solution into the fat in a thin steady stream while stirring slowly and evenly. Continue stirring for about 10 to 20 minutes until the solution is thick and difficult to stir.

Precaution: If the lye is added too fast and with too vigorous stirring, the ingredients will separate into two layers. If the soap mixture does not become thick within 1/2 hour and there is an oily layer on top, perhaps it is too warm. Cool the container in cold water and keep stirring from the sides and bottom. On the other hand, if the mixture is lumpsy, it may be too cold. Set the pan in warm water and stir until the lumps disappear.

4. Line the molds with paper or cotton cloth dipped in cold water and squeezed. This prevents the soap from leaking through seams and sticking to the mold. If cardboard boxes are used, tape the seams with adhesive tape and support the sides of the boxes so that they are not distorted by the weight of the soap mixture. Pour the thickened soap into the molds. Cover and keep warm for 24 hours. Remove and cut into bars. Age the bars for 2 weeks in a dry place.

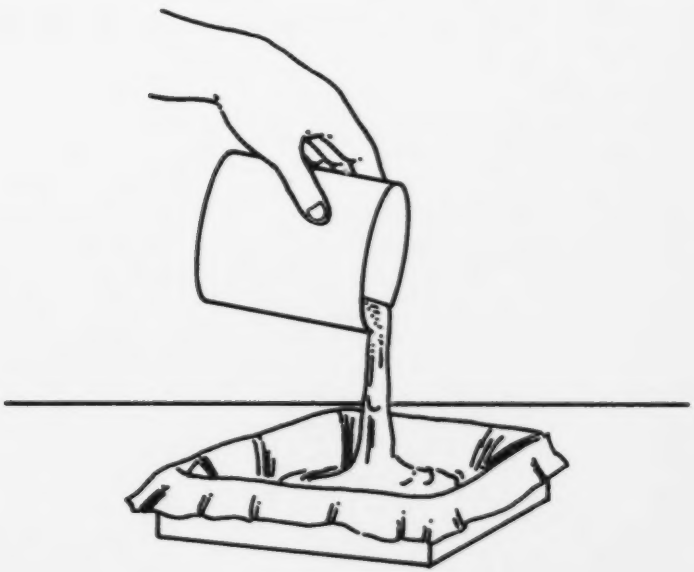

Figure 6

## Construction of Hydrometer Using Ballpen Filler

### Materials

table salt
water
small colorless medicine bottle (about 10 cm high)
empty ballpen filler with straight metal point
sodium hydroxide or lye (commercial)
modeling clay or bubblegum

### Procedure

1. Get an empty ballpen filler and remove the point.
2. Insert a piece of modeling clay in the filler.
3. Then place back the point to the filler next to the clay. See figure 7.

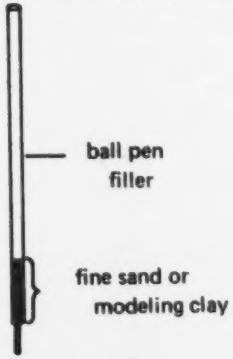


**Figure 7**

4. To one-half cup water, add salt little by little, stirring while you do so. Keep adding salt until no more dissolves. Transfer the salt solution and excess salt to a bottle, stopper and leave overnight. The next day, observe if there is still any excess salt. This is a saturated salt solution. Label the bottle. This can be kept for a long time provided there is always excess salt.
5. See figure 8. Transfer some of the saturated salt solution to a small clear medicine bottle (8a). Mark the upper level of the solution on the outside of the bottle (8b). Place the ballpen filler in the solution (8c). If it sinks to the bottom, cut portions of the upper end of the filler until it floats. Mark the level of the tip of the filler on the outside of the bottle (8d).

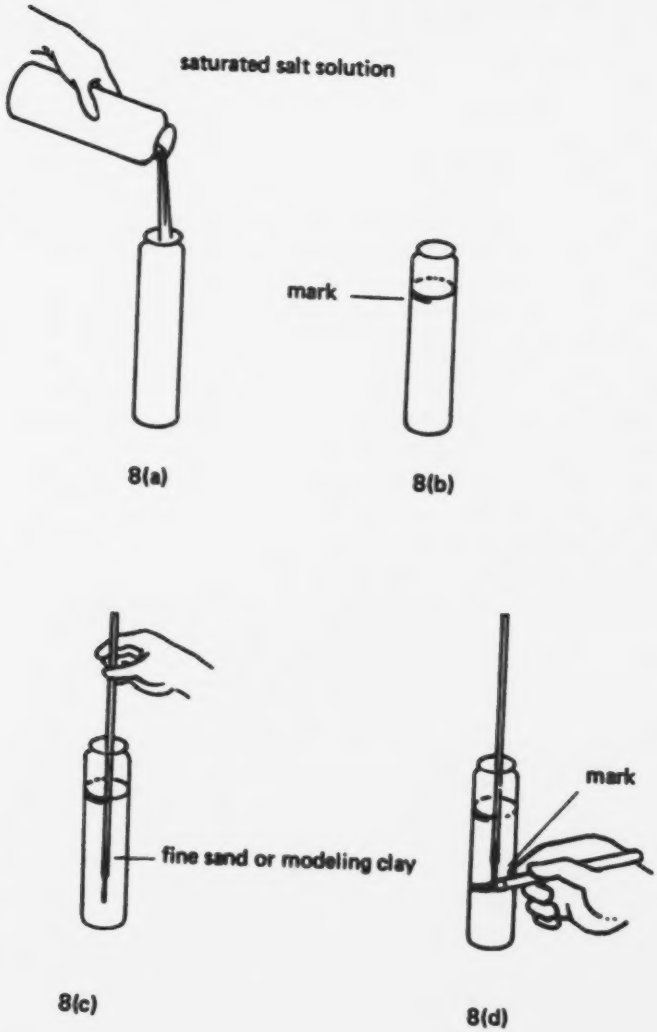
saturated salt solution
mark
8(a)
8(b)
fine sand or modeling clay
mark
8(c)
8(d)

Figure 8

## APPENDIX 1

### OILS

The term "oil" is applied to any liquid substance* or mixture of substances that give a greasy feel.

*Natural fats and oils* that occur in animals and plants are a mixture of organic substances called esters.* The main ester found in coconut oil is laurin*, $[CH_3(CH_2)_{10}COO]_3C_3H_5$. Oils are liquid and fats are solid at room temperature. Vegetable oils, such as coconut, corn, peanut and soybean oils, serve as food for the seeds and fruits of the plants where they are found. These oils are extracted* and used as edible oils for salads, cooking and for manufacture of soaps. In animals, the stored fat is a source of energy. Fats below the skin serve to protect organs and conserve body heat. Fats surrounding vital organs protect them against injury. Pork fat is also used for manufacture of soap.

*Volatile or essential oils* give pleasant odors to some leaves, stems, flowers and fruits. Some essential oils are esters while others belong to different classes of volatile compounds*. Unlike the natural oils and fats, these volatile oils can be distilled* alone or with steam. For this reason they are called *volatile* oils. They are more commonly called essential oils because of their essence or pleasant odor. Pineapple odor is due to an ester, methyl butyrate ($C_3H_7COOCH_3$). Oil of cloves is 90%engenol which is not an ester. Oil of cloves is a mild dental antiseptic and pain reliever. When one cannot immediately go to a dentist, a home treatment for an aching decayed tooth is to pack the cavity with cotton soaked in oil of cloves.

Petroleum oil is mainly a mixture of hydrocarbons* that can be separated by fractional distillation*. The different mixtures of hydrocarbons separated by fractional distillation are used as fuels.

### SOAP

Soap is one of two kinds of "detergent", the other being soapless cleansing agents. The word "detergent" comes from the Latin "tergere" meaning "to clean." Detergents, therefore, are substances which act with water to clean things. They improve the power of water to penetrate the pores of textiles making the removal of stains or dirt easier. Soap is made by boiling animal and/or vegetable fats and oils with alkali, sodium hydroxide (NaOH) or potassium hydroxide (KOH). Sodium soaps are hard while potassium soaps are soft.

Most soapless detergents, sold mainly in powdered form, are the result of chemical changes between petroleum chemicals and sulfuric acid, or between

high molecular mass alcohols obtained from animal fats and sulfuric acid, or between alcohols and ethylene oxide. Soapless detergents have the advantage over soap in that they can be used with hard water or seawater. Hard water contains soluble calcium and magnesium salts. These salts form soluble compounds with soapless detergents but form insoluble solids with soap. Soap, therefore, does not lather easily with hard water. The insoluble solids can be seen as the "ring" around the sink, pail or *batya*. These solids are also deposited on clothes during washing, later causing black stains or yellow stains upon ironing.

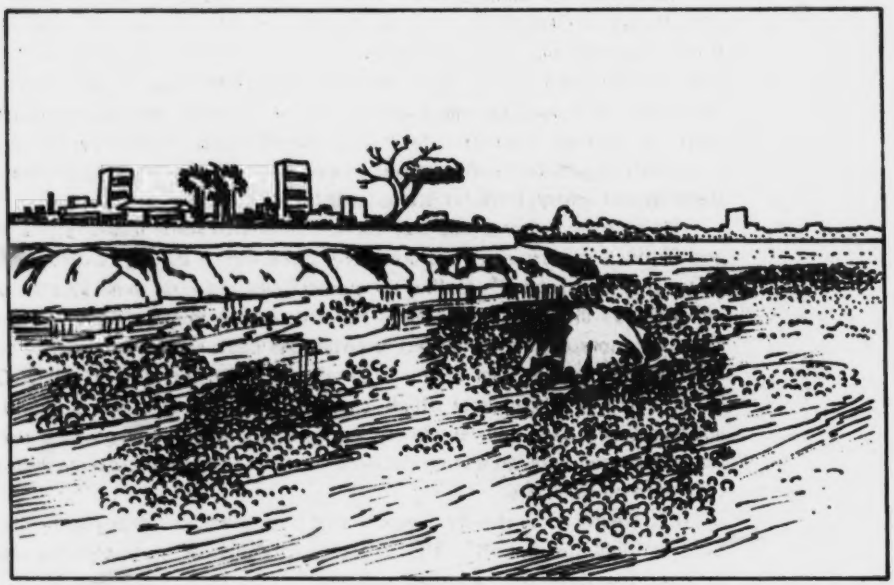

**Figure 9**

Wash water with soapless detergents, however, cause permanent foams in rivers and sewage waters. The reason for this is that detergents are not digested by bacteria (not biodegradable).

This problem was solved by manufacturing biodegradable detergents. But these detergents contain phosphates which favor the growth of algae in waterways. When algae die, oxygen is used up in their decomposition. Lack of oxygen in the water destroys animal aquatic life since all living things need oxygen to breathe. Phosphates also contain arsenic which can cause skin diseases (dermatitis) and delay in the healing of wounds. Arsenic can further be absorbed through the unbroken skin, accumulating slowly in the body until danger levels are reached. Analysts have found arsenic in several household detergents.

Amounts of arsenic close to the allowable maximum of 10 parts per billion in drinking water have been found in some rivers.

Some manufacturers add enzymes to detergents to cause the breakdown of oils that hold dirt to clothes. These enzymes cause skin irritation or lung disorders among people who use such detergents over a long period of time.

The American Soap and Detergent Associations say that arsenic is chemically bound to phosphates, and therefore, cannot be absorbed. They also claim that enzymes are safe. Because of these conflicting opinions, many think it is safer to use soap.

## History of Soap

Before people knew about soap, they clean themselves with olive oil, earth or plant ashes. They also rubbed their bodies with bran or sand or pumice stone. No one knows exactly when man used soap but there are several legends about it.

One concerns a Gaul, an inhabitant of an ancient region of Europe including most of what is now France and in earlier times also including North Italy.

This Gaul was said to have very unruly hair.

So he made a hair dressing of goat oil and beech-tree ashes.

One day he got caught in a rainstorm and his hairdressing began to bubble and foam.

When he washed it away his hair felt clean and soft.

**Figure 10**

A more believable legend comes from Rome.

**Figure 11.** On Sapo Hill in Rome, grease from sacrificial animals mixed with the ashes of altar fires.

**Figure 12.** This mixture flowed downhill and formed a slippery clay-like material on the banks of the Tiber river.

**Figure 13.** When women washed their clothes by pounding over this material, they found that it foamed.

**Figure 14.** The clothes became cleaner.

Historically, soap has been known in the Middle East for at least 2,300 years. According to Pliny the Elder, the Phoenicians prepared soap from goat's tallow* and wood ashes. Soap was brought to Europe by the Phoenicians about 600 B.C. It was used to barter with the Gauls.

The Celts produced soap from animal fats and plant ashes. They named the product *saipo* from which the word *soap* is derived. The Celts are members of early Indo-European peoples in iron-age Europe and pre-Roman Europe inhabiting the British Isles, Spain and Asia Minor.

The Roman Empire manufactured and used soap but it is not known whether they learned the process of making it from the Ancient Mediterranean people or from the Celts.

Soap for washing and cleaning was not recognized until the 2nd century after Christ. Before that it was used only for medicinal purposes, such as the treatment of scrofulous sores, a skin disease of tubercular origin. The Greek Galen, mentions it as a medicine and for cleaning the body. The writings of the Arab scholar Jabir ibn Hayyan (Geber), mention soap as a cleansing agent.

In the middle ages (500 A.D. to about 1500) the making of soap in Europe first started in Marseilles, Lake Genoa, and then Venice. Italians in the early 600's made crude soap from fats and oils and potash from beechwood ash.

Spain prepared Castile soap from olive oil instead of animal oil.

From 800 to 1200, France led all European countries in soapmaking. Hard bar soap was made from soda of seaweeds.

Soapmaking in England appeared at the end of the 12th century in Bristol. Whale oil, olive oil, and tallow were used in soap making. A small community of soapmakers grew in the neighborhood of Cheapside, London in the 13th and 14th centuries.

Though Germany manufactured some soap, it was little used in Central Europe. A box of soap presented to the Duches of Juelich in 1549 caused a sensation. In 1672 when a German, A. Leon sent Lady Von Schleintz a parcel of soap from Italy, he had to include a detailed description of how to use the unknown product.

Soapmaking remained a primitive art until the 16th century when techniques of using lime (calcium oxide) were discovered to convert potash to potassium hydroxide, and procedures to salt out soap.

Then soap became widely used and soapmakers had to pay taxes on all soap produced. After the Napoleonic wars, the tax rose so high that soap-boiling pans were fitted with lids. These lids were padlocked every night by tax collectors to prevent illegal production of soap at night. In 1853 the tax was abolished.

After the 1800's, coconut oil from the Philippines, palm oil from Africa babassu oil from South America, sesame oil from Japan and soybean oil from China were used in soapmaking.

Scientific soapmaking started in the early 1800's. In 1791, a Frenchman, Nicolas Leblanc, produced sodium hydroxide from salt. Wood and seaweed ashes were no longer used. In our present age, sodium hydroxide is produced by the electrolysis of salt solution.

In the 19th century, Chevreul described the nature of fats and oils. This knowledge made it possible to produce both toilet and laundry soaps.

In the first half of the 20th centiry, methods of bleaching and deodorizing fats were used. Soap became so common in use that Justus von Liebig, a German chemist, declared that the quality of soap consumed by a nation was an accurate measure of its wealth and civilization.

## APPENDIX 2

### Preparation of 18% Lye Solution

#### Materials

hydrometer (improvised) (See page 5 for the construction procedure.)
5 tsp solid lye
1/2 cup water
glass container

#### Procedure

1. Dissolve 5 tsp of solid lye in 1/2 cup of water in a glass or plastic container.
2. Test the strength of the lye solution using the improvised hydrometer.
3. Using the dry marked medicine bottle, pour the lye solution up to the upper mark. Put the improvised hydrometer and observe the level of the pointed end. If it coincides with the lower mark on the bottle, the lye solution is 18%. If the point is below the mark, add some more solid lye to the lye solution in the container and re-test for its strength until it is the same as that of the saturated salt solution. If the point is above the mark, add water little by little to the original lye solution until its strength is the same as the saturated salt solution.

### Preparation of Soap Using Lye from Wood Ash

For the preparation of lye for soap making, see module "Lye from Wood Ash," SEC publication, UP Diliman, Quezon City.

#### Materials

2 wide-mouthed bottles with the same diameter from top to bottom
big can or kettle
bamboo or wire rack
2 wooden bamboo sticks rounded like a pencil (one for stirring and one for pouring)

Procedure

1. Put 1 tablespoon of used oil in one of the wide-mouthed bottles and 6 tablespoons of strong ash lye in the other.
2. Then place the two wide-mouthed bottles in a kettle with a bamboo or wire rack at the bottom.

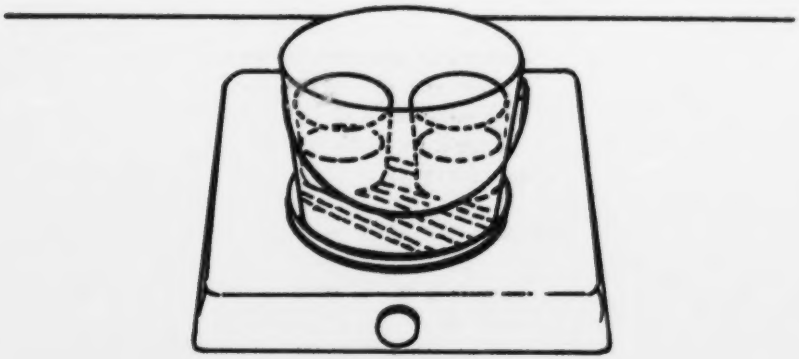

Figure 15

3. Put water in the kettle just enough to be in the same level of the oil in the bottle. Bring to a boil.
4. When the water boils, remove the bottles. Using a bamboo stick pour the lye slowly in steady stream into the oil, stirring until the mixture becomes thick.

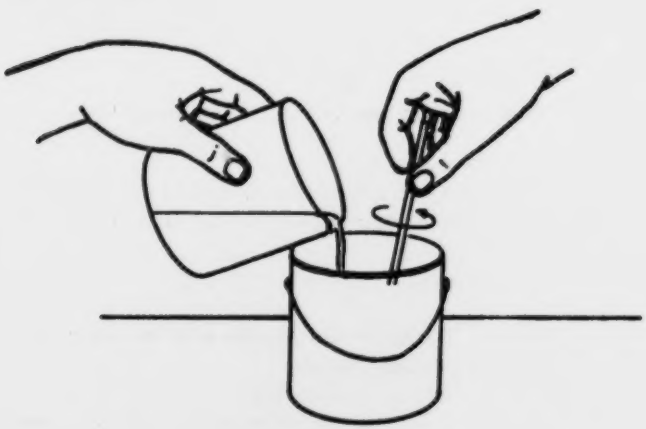

Figure 16

5. You may add a few drops of cologne or perfume at this point.
6. Cover and let stand overnight. The soap will form an upper layer with liquid at the bottom.
7. The next day, take out the soap from the container. Wash the soap quickly with water and dry it with a piece of cloth.
8. Let it stand until it is completely dry.

Note: Depending upon the source of the ash, you may need to use less or more lye.

If the soap is good, you can make more soap using the same proportions of oil and lye (1 part oil to 6 parts lye).

## How Soap Cleans

Soap is used for bathing, shampooing the hair, washing hands and dishes and laundering clothes. Good health depends in part on personal cleanliness.

The use of soap in washing involves physical and chemical processes such as (1) solubilization*, (2) wetting action, (3) emulsifying* action, and (4) dispersing* action.

Try this yourself. Put some drops of water on a greasy surface. Water does not easily get through a greasy or dirty surface. It soaks through the areas around it but runs off the greasy surface or stands on top of the grease without penetrating it. Why does this happen? The answer is that water has a high surface tension. Liquids, such as water, have a surface. Let us represent the particles or molecules of water

$$\begin{matrix} H+ \\ H+ \end{matrix} > O^{-}$$

as $+^{-}$. The particles or molecules at the surface are attracted to each other and to the molecules in the body of the liquid. Within the body of the liquid a molecule is acted upon by molecular attractions which are distributed more or less symetrically* about the molecule. The molecules at the surface are only partially surrounded by other molecules. Molecules at the surface, therefore, have a greater attraction for each other and are drawn together more than the molecules within the body of the liquid. These greater attractive forces at the surface cause the molecules to pull the whole mass of liquid into as small a space as possible. This tendency causes the liquid to behave as if it were covered by an elastic film under tension. This property of a liquid surface is called *surface tension*. Surface tension pulls small amounts of water outside a container into spherical forms like raindrops or drops of liquid set free from medicine droppers.

Steel is much denser than water. But if you carefully place a steel needle lengthwise on the surface of water in a container, the needle will float due to

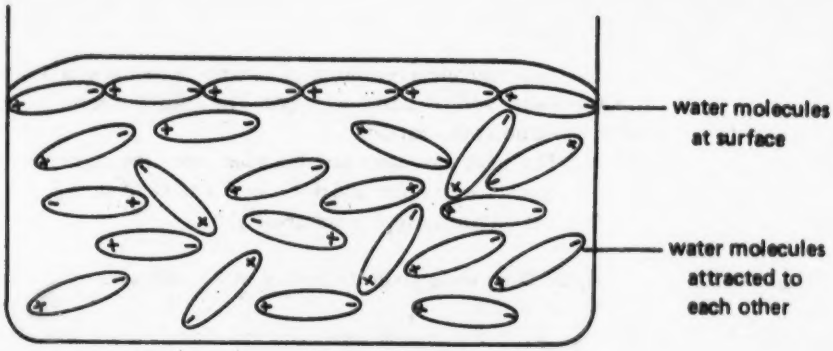


Figure 17

the surface tension of water. If you are a good observer, you will see that the surface of the water bends down under weight of the needle. Detergents, such as soap, act on the surface and decrease surface tension, that is, the attraction of the molecules at the surface for each other. This results in an increase of the spreading and wetting ability of water.

Figure 18. A steel needle floats on the surface of water.

How does soap decrease surface tension?

Knowledge of the chemical composition of soap will help to show how soap decreases surface tension.

Hard soap is the product of a chemical change between the esters in oil and soda lye.

Chemists represent the change as follows:

$$\underset{\text{ester in oil}}{(RCOO)_3C_3H_5} + 3\,\underset{\text{soda lye}}{NaOH} \rightarrow \underset{\text{hard soap}}{RCOONa} + \underset{\text{glycerol}}{C_3H_5(OH)_3}$$

Sodium soap, RCOONa, is hard soap while potassium soap, RCOOK, is soft soap. R is a hydrocarbon chain with at least 10 and not more than 18 carbon atoms. Laurin, the main ester in coconut oil has a carbon chain of 11 atoms.

$$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2-$$

Dirt is held by a thin film of oil or grease at the surface to be washed. The long chain of carbon atoms (R) in soap does not dissolve in water but dissolves in oil or grease. The chain is thus held on the fibers of fabrics or the surface of solids like dirt. The other end of soap, $COONa^+$, is water soluble. Soap thus acts as a bridge between the oil surface that causes dirt to stick to clothes and the water surface.

If we represent soap, $R - COONa^+$, as $R - -Na^+$ and water molecules as $+-$, figure 19 shows how soap acts. The attraction of the water molecules for each other at the surface (surface tension) decreases as the water molecules are attracted to the $- COONa^+$ end of soap. Water spreads and wets the fabric

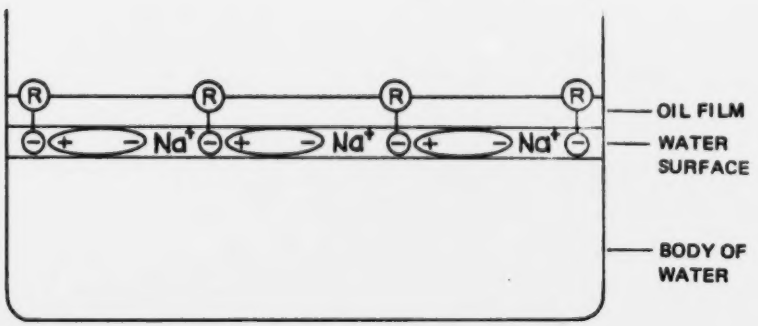


**Figure 19**

under the oily layer. Rubbing, squeezing and agitation cause the oil film with the dirt to break away from the fabric. The oil breaks into finely dispersed drops in the soapy water. If the tiny oil drops and dust particles do not remain suspended and separated from each other, they will form bigger particles. These particles will be deposited again on the cleaned surface. Soap acts as a protective agent to keep oil in colloidal dispersion in water (colloidal emulsion). See figure 20.

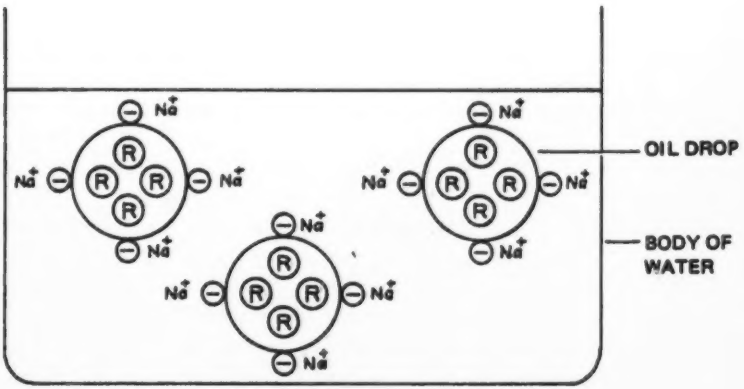


**Figure 20**

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## GLOSSARY

Acrolein – a poisonous volatile liquid with a pungent odor and an irritating vapor obtained by the removal of water (dehydration) from the glycerole or part of oil or fat.

Compound – a substance the particles or molecules of which are made up of two or more different kinds of atoms in a fixed composition. For example, water is a compound each molecule of which is made up of 2 atoms of hydrogen and one atom of oxygen.

Disperse – to cause the particles of a substance to scatter among the particles of another substance.

Distill – to purify a volatile liquid from a non-volatile solid by changing the liquid into vapor by the application of heat and then condensing it back into liquid by cooling the vapor.

Emulsify – to cause the dispersion of a liquid in another liquid or droplets of colloidal size (1 nm to 200 nm) to form a colloidal mixture called an emulsion.

Ester – a class of organic compounds produced by a chemical change between an organic acid (RCOOH) and an alcohol (ROH). The general formula of an ester is RCOOR.

Extract – the drawing out of something from a mixture as oils from plants by pressure or by the use of solvents.

Fractional distillation – the separation of two or more liquid substances by making use of their differences in boiling temperatures as heat is applied, the liquid with the lower boiling temperature volatilizes first and is then condensed back into a liquid.

Hydrocarbons – organic compounds made up of hydrogen and carbon.

Solubilization – process whereby the particles of a substance mix with the particles of a liquid substance to form a homogeneous mixture, a solution.

Substance – a kind of matter in which the particles or molecules are all the same. As a result, a substance has a definite melting or boiling temperature and a definite set of properties.

Symmetrical – having a proper balance between the arrangement of the parts. Particles symmetrically arranged exert equal forces of attraction in all directions.